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(54) Title: TRAINING PROJECTILE OF PLASTICS MATERIAL

(57) Abstract

A training round comprises a bullet made of plastics material containing a filler such that the bullet has a specific gravity of from 3 to 7, the plastics material being relatively hygroscopic compared to nylon 11.

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Training projectile of plastics material.

The present invention relates to training aids and has particular relevance to bullets for training purposes but is not limited thereto.

Training bullets have been proposed comprising plastics material either encapsulating or filled with metal powders. Difficulties arise however in producing practice bullets which are easily manufactured, are stable against corrosion and against dimensional changes on storage, are stable against premature disintegration when fired and yet disintegrate on impact, and which are adequately accurate.

EP-B-0096617 (S.F.M.) discloses a training round having a bullet moulded in a mixture of nylon, a powder of a ductile metal, and a solid lubricant.

Training rounds are used in large numbers and even small reductions in unit costs will be important to the industry. The material costs are very significant in manufacturing such rounds.

Although EP-B-0096617 is not specific as to the exact nylon to use, it has in practice been the expectation of those skilled in the art that amongst the nylons, only those such as nylon 11 having a low water absorbence characteristic would be suitable for producing bullets which would be stable upon long term

storage in humid conditions. The expectation was that any other type of nylon, or any other plastics material absorbing water more readily, would swell in humid conditions making the rounds liable to cause jamming or excessive back pressure on firing. A surprising finding is that even nylon materials such as nylon 6 and nylon 66, once containing a substantial level of metal powder filler are sufficiently stable against water absorption. Both these materials have a higher water absorption factor than nylon 11 but we find that this does not prevent their satisfactory use in training ammunition of this kind. Nylon 11 is an expensive grade of nylon. More hygroscopic grades are cheaper but have previously been thought unsuitable for these purposes.

Accordingly, the present invention provides a bullet comprising a matrix of plastics material having a water absorption factor similar to or greater than that of nylon 66 containing a filler material effective to raise the specific gravity of the bullet to from three to seven, preferably to from 4 to 6.5.

The water absorbtion factor is defined herein to mean the percentage by weight of water in the unfilled plastics at equilibrium under standard conditions of humidity and temperature.

For instance, at 50% relative humidity at 23°C, the equilibrium water content by weight of nylon 11 is

0.8% whereas that of nylon 6 is 9.5% and that of nylon 66 is 8.5%.

Within this constraint the plastics matrix may be made from a wide variety of plastics materials but the material is preferably thermoplastic and should be selected to have sufficient stability against high temperature bearing in mind that a round may be in the chamber of a weapon for a considerable period when the weapon is hot and must withstand this temperature without charring or deforming or swelling so as to jam the weapon.

Preferably, the plastics matrix is of nylon 6 or nylon 66.

Preferably the filler is finely divided metal. The filler may be copper, bronze, tungsten or a mixture of two or more thereof, or may be a metal compound of adequately high density, e.g. tungsten oxide.

The problems of bullet design are particularly accute in connection with 9mm, 0.357 and 0.38 special ammunition. Rounds for different types of weapon have to fulfil different requirements. Thus 9mm luger type rounds for automatic pistols and many automatic sub-machine guns exemplify one type of requirement. They have to fit within standard magazines, have to pass through the automatic loading mechanisms without jamming and must blow back the automatic loading mechanism when fired. The length and diameter of the

rounds are fixed by the physical constraints of the weapon. The length of the bullet must be chosen so as to leave room in the cartridge case for a powder charge large enough, given the bullet mass, to blow back the weapon. Generally, raising the bullet mass by increasing the specific gravity by using more metal filler or a heavier metal filler brings a cost penalty. Also, changing the metal filler loading alters the frangibility of the bullet. Accordingly, there is a problem in selecting bullet shape and composition to achieve reliable weapon operation at minimum cost. We have developed 9mm luger ammunition having a number of features which solve this problem. First, there is the use of less expensive, more hygroscopic grades of plastics materials discussed above.

Secondly, there is the selection of one of two types of filler to provide two specific gravity types. The first, suitable for general purpose use, is from 4 to 5.5 (preferably 4.6 to 5.0) specific gravity and contains copper powder as a filler.

It should be noted that bullets as described in EP-B-0096617, of the shape and composition exemplified have been found unsuitable in 9mm calibre.

The second type is designed to meet the more stringent requirements of the MP5 type of sub-machine gun, has a specific gravity of from 6 to 6.8 and

contains a mixture of copper and tungsten power as filler.

To blow back the automatic mechanism of this type of modern machine weapon reliably requires a heavier bullet than is easily obtainable using fillers such as copper and bronze. The use of lead as a filler is undesirable because of the toxicity of lead. The use of tungsten enables the production of a bullet which is suitable for blowing back the automatic mechanism of any conventional weapon, which has the required ability to fragment on impact and which is non-toxic. It is however vital to keep the tungsten content as low as possible to achieve minimum cost without sacrificing performance.

Preferably bullets according to the invention contain a lubricant. This is preferably uniformly dispersed through the plastics material, but may be a particulate material such as graphite or molybdenum disulphide. The lubricant is preferably a soap such as a stearate, e.g. calcium stearate. The lubricant preferably has a melting point below that of the plastics material.

A first particularly preferred composition is approximately:-

nylon	-	11%	(by weight)
copper filler	-	88%	" "
lubricant	-	1%	" "

and has a specific gravity of approximately 4.8.

A second particularly preferred composition is approximately:-

nylon	-	8%	(by weight)
copper filler	-	44.5%	" "
tungsten filler	-	46.5%	" "
lubricant	-	1%	" "

and has a specific gravity of approximately 6.4.

In order to achieve adequate bullet weight within length and diameter constraints we have devised a bullet shape which is particularly advantageous.

Thus the invention includes bullets which are shaped as a round nosed cylinder in which the nose approximates to a hemisphere of radius equal to the area of said cylinder.

Preferably, the nose has a flat tip, suitably provided by a substantially plánar region approximately 3 sq mm in area, e.g. a circle of diameter about 2mm.

The exact shape must be tailored to allow reliable feeding through the loading mechanism of a satisfactory range of weapons. To this end we prefer that the bullet reduces in transverse cross-sectional area more rapidly than would a true hemisphere on moving toward

the tip over the region of the round nose adjoining the cylindrical part thereof.

Preferably also, the bullet reduces in transverse cross-sectional area more slowly than would a true hemisphere on moving towards the tip in the region of the round nose adjacent the tip.

Preferably, the cross-sectional radius is reduced by about 4.5% compared to a true hemisphere of appropriate diameter at about 20% of a radius distance into the nose, toward the tip from the junction between the nose taken as a true hemisphere and the cylindrical part of the bullet.

Preferably, said relative reduction in cross-section radius is at a maximum at about said 20% of a radius distance into the nose and the cross-section approximates more closely to that of a hemispherical nose both at points closer to the nose of the bullet and at points further from the nose of the bullet.

Preferably, such bullets are of 9mm (0.357 inch) nominal calibre but preferably their actual diameter is 9.093mm (0.358 inch).

For revolver ammunition, the same compositions and bullet shape may be employed with advantage. The constraints in bullet design which lead to this result are however quite different. There is of course no automatic reloading mechanism to blow back or to jam.

It is more desirable however to have a bullet weight approximating more closely to that of a ball round because otherwise the aiming of such relatively low velocity weapons needs to be adjusted. It would be undesirable to increase the powder charge to compensate for a lighter bullet because the increase in back pressure could pose a hazard.

We have found that some unreliability in the operation of metal filled plastics training ammunition can be corrected by manufacturing the bullets to be very slightly in excess of the diameter corresponding to the nominal calibre. Such excess should normally be about 0.3%. It is preferred generally that the bullets should be from 0.0127 to 0.038cm oversize in diameter , preferably about 0.0254cm (0.001 inch).

This improves the obturation of the barrel without causing jamming or excess back pressure and hence allows the minium bullet weight, and hence minimum filler loading, to be employed reliably.

Bullets according to the invention may be made in any calibre, including calibres for automatic and non-automatic small arms, automatic and non-automatic rifles and for cannon, e.g. up to thirty millimetre calibre or even higher.

The invention will be illustrated by the following examples.

Example 1

Bullets were moulded to a diameter of 9.093mm, from an intimate mixture of the following components:-

Nylon 66	20%	(by weight)
Bronze	79%	" "
Calcium stearate (lubricant)	1%	" "

The resulting bullets had a specific gravity of approximately four and were stable against deterioration on prolonged storage at high relative humidity. They were found to be accurate in use, and to disintegrate on impact.

Example 2

Bullets were moulded to a diameter of 9.093mm from a intimate mixture of:-

Nylon 66	15%	(by weight)
Tungsten powder	67%	" "
Bronze powder	17%	" "
Calcium stearate	1%	" "

The bullets were found to have the characteristics in use of those in Example 1.

The bullets were of a generally round nosed shape with the extreme tip flattened into an almost plane circular region of about 2mm diameter, providing a blunt nose.

The accompanying figure illustrates a preferred shape for a bullet according to the invention.

As can be seen, the general shape is cylindrical having a rounded nose 10 approximating to a hemisphere with the extreme tip 11 flattened. The shape is more exactly defined by the following numerical parameters.

Diameter (mm)			Distance from base (mm)		
A	=	2	A^1	=	16.5
B	=	4.80	B^1	=	16.0
C	=	6.80	C^1	=	15.0
D	=	8.00	D^1	=	14.0
E	=	8.60	E^1	=	13.0
F	=	8.80	F^1	=	12.0
G	=	9.00	G^1	=	11.0
H	=	9.09	H^1	=	10.0

for a bullet diameter of 9.093mm.

A hemisphere having a diameter of 9.093mm and passing through the circle defined by the flat tip would pass somewhat within the body of the bullet near the tip as indicated on an enlarged scale by the dotted line 1. It would then pass outside the bullet as the cylindrical portion is approached as indicated by the dotted line 2. At the level indicated in E, the actual radius of the transverse cross-section is about 4.5% less than would be the case if the nose were

hemispherical. The level E is about 20% along the radius of the notional hemisphere in the direction of the tip.

Example 3

Bullets were moulded to the shape shown in the figure with a diameter of 9.093mm from a composition consisting of an intimate mixture of:-

Nylon 6	11.2%	(by weight)
Calcium stearate	1.2%	" "
Copper powder	87.6%	" "

The specific gravity was 4.8 and the shape and size of the bullets was as shown in the figure. The resulting bullets were dimensionally stable in high humidity, were accurate in use, disintegrated into small pieces on impact and were fired satisfactorily from automatic pistols and Sterling sub-machine guns.

Example 4

Bullets were moulded from a composition consisting of an intimate mixture of:

Nylon 6	8.24%	(by weight)
Calcium stearate	1.03%	" "
Copper powder	44.34%	" "
Tungsten powder	46.39%	" "

The bullets had all the characteristics described in Example 3 except that their specific gravity was 6.4 and in addition they could be fired reliably from an HP5A2 sub-machine gun.

Example 5

Bullets were manufactured from a composition consisting of an intimate mixture of:

Nylon 6	8.87%	(by weight)
Calcium stearate	1.1%	" "
Copper powder	53.85%	" "
Tungsten powder	36.18%	" "

The bullets had all the characteristics described in Example 3 save that they had a specific gravity of 6.0.

Whilst the invention has been described with reference to specific characteristics of the preferred embodiments, many modifications and variations thereof may be made within the scope of the invention.

The invention includes a bullet having substantially the following composition:-

Nylon	11%	(by weight)
Copper filler	88%	" "
Lubricant	1%	" "

and having a specific gravity of approximately 4.8.

This invention also includes a bullet having substantially the following composition:-

Nylon	8%	(by weight)
Copper filler	44.5%	" "
Tungsten filler	46.5%	" "
Lubricant	1%	" "

and having a specific gravity of approximately 6.4.

The invention further includes a bullet comprising a matrix of plastics material containing a filler material effective to raise the specific gravity to from 3 to 7, which is shaped as a round nosed cylinder in which the nose approximates to a hemisphere of radius equal to that of said cylinder.

Preferably, the nose has a flat tip.

Preferably, the flat tip is provided by a substantially planar region approximately 3 sq mm in area.

Preferably, the bullet reduces in transverse cross-sectional area more rapidly than a true hemisphere on moving toward the tip over the region of the round nose adjoining the cylindrical part thereof.

Preferably, the cross-sectional radius is reduced by about 4.5% compared to a true hemisphere at about 20% of a radius distance into the nose toward the tip from the junction between the nose taken as a true hemisphere and the cylindrical part of the bullet.

Preferably, said relative reduction in cross-sectional radius at a maximum at about said 20% of a

radius distance into the nose and wherein the cross-sectional radius approximates more closely to that of a hemispherical nose both at points closer to the nose of the bullet and at points further from the nose of the bullet.

The invention further includes a bullet comprising a matrix of plastics material containing a filler material effective to raise the specific gravity to from 3 to 7, which is oversize in diameter for its nominal calibre by about 0.3%, or which is oversize in diameter for its nominal calibre by about 0.0254 mm (0.001 inch).

The invention includes a training round comprising a bullet as described herein.

CLAIMS

1. A bullet comprising a matrix of plastics material having a water absorbtion factor similar to or greater than that of nylon 66 which matrix contains a filler material effective to raise the specific gravity of the bullet to from 3 to 7.

2. A bullet as claimed in Claim 1, wherein the plastics material is nylon 6 or nylon 66.

3. A bullet as claimed in Claim 1, wherein the filler is finely divided metal.

4. A bullet as claimed in Claim 3, wherein the filler is copper, bronze, tungsten or a mixture of two or more thereof.

5. A bullet as claimed in Claim 4, having a specific gravity of from 4 to 5.5 and containing copper powder as a filler.

6. A bullet as claimed in Claim 4, having a specific gravity of from 6 to 6.8 and containing a mixture of copper and tungsten powders as filler.

7. A bullet as claimed in any preceding claim containing a lubricant.

8. A bullet as claimed in Claim 7, wherein the lubricant is uniformly dispersed through the plastics material.

9. A bullet as claimed in Claim 8, wherein the lubricant is a soap.

10. A bullet as claimed in Claim 9, wherein the lubricant is a stearate.

11. A bullet as claimed in Claim 1, having substantially the following composition:-

Nylon	11%	(by weight)
Copper filler	88%	" "
Lubricant	1%	" "

and having a specific gravity of approximately 4.8.

12. A bullet as claimed in Claim 1, having substantially the following composition:-

Nylon	8%	(by weight)
Copper filler	44.5%	" "
Tungsten filler	46.5%	" "
Lubricant	1%	" "

and having a specific gravity of approximately 6.4.

13. A bullet as claimed in any preceding Claim, which is shaped as a round nosed cylinder in which the nose approximates to a hemisphere of radius equal to that of said cylinder.

14. A bullet as claimed in Claim 13, wherein the nose has a flat tip.

15. A bullet as claimed in Claim 14, wherein the flat tip is provided by a substantially planar region approximately 3 sq mm in area.

16. A bullet as claimed in any on of Claims 13 to 15 wherein the bullet reduces in transverse cross-

sectional area more rapidly than a true hemisphere on moving toward the tip over the region of the round nose adjoining the cylindrical part thereof.

17. A bullet as claimed in Claim 16, wherein the cross-sectional radius is reduced by about 4.5% compared to a true hemisphere at about 20% of a radius distance into the nose toward the tip from the junction between the nose taken as a true hemisphere and the cylindrical part of the bullet.

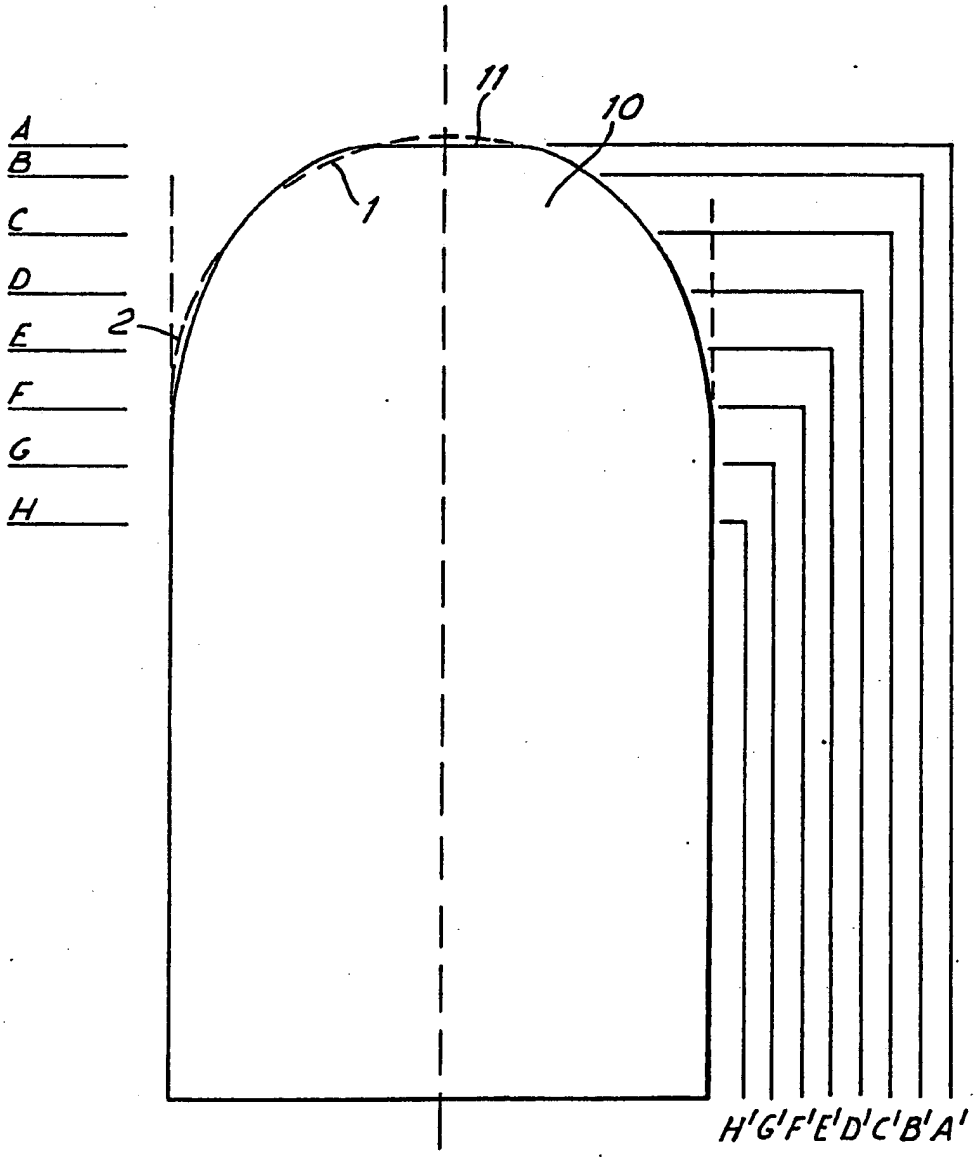
18. A bullet as claimed in Claim 17, wherein said relative reduction in cross-sectional radius at a maximum at about said 20% of a radius distance into the nose and wherein the cross-sectional radius approximates more closely to that of a hemispherical nose both at points closer to the nose of the bullet and at points further from the nose of the bullet.

19. A bullet as claimed in any one of Claims 13 to 18, which is of 9mm (0.357 inch) calibre.

20. A bullet as claimed in Claim 19, having a diameter of 9.093mm (0.358 inch).

21. A bullet as claimed in any preceding claim, which is oversize in diameter for its nominal calibre by about 0.3%.

22. A bullet as claimed in any preceding claim, which is oversize in diameter for its nominal calibre by about 0.0254 mm (0.001 inch).


A
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INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 88/00397

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: F 42 B 11/40

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	F 42 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 2995090 (DAUBENSPECK) 8 August 1961 see column 1, lines 47-64; column 2, lines 52-72; column 3, lines 1-8; column 6, lines 41-75; column 7, lines 1-30; column 9, lines 37-67; figures 1-3 --	1-5,7-10
Y	EP, A, 0096617 (NOTTIN) 21 December 1983 see page 2, lines 9-16; page 3, lines 12-34; page 5, lines 1-22; page 6, lines 28-33; page 7, lines 1-7 cited in the application --	1-5,7-10
Y	US, A, 3123003 (LANGE) 3 March 1964 see column 1, lines 57-70; column 2, lines 40-70; column 3, lines 23-31 --	9,10
A	US, A, 3785293 (BARR) 15 January 1974 see column 2, lines 4-37 -- ./.	1,2

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
21st July 1988	30 SEP 1988
International Searching Authority	Signature of Authorized Officer
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

International Application No. PCT/GB 88/00397

FURTHER INF RMATION CONTINUED FROM THE SECOND SHEET

A	GB, A, 2092274 (SPENCE) 11 August 1982	

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers....., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

Claims 1, 2-12
Claim 1, 13-22

Please refer to Form PCT/ISA 206 dated 29th July 1988

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

1, 2-12

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 8800397 SA 22275

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 21/09/88 The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 2995090		None	
EP-A- 0096617	21-12-83	FR-A,B 2528564	16-12-83
		GB-A- 974318	
US-A- 3785293	15-01-74	None	
GB-A- 2092274	11-08-82	None	